PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

IN RE APPLICATION OF:	Eric J. BERGMAN	EXAMINER:	Z. EL ARINI
APPLICATION NO.:	09/621,028	ART UNIT:	1746
FILED:	JULY 21, 2000	CONF. NO:	4066

FOR: **PROCESS AND APPARATUS FOR TREATING A WORKPIECE SUCH AS A SEMICONDUCTOR WAFER**

RESPONSE

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

In reply to the Office Action mailed December 23, 2002, please enter the following response:

REMARKS

Claims 1-24, 26, and 27 are pending in the application. A terminal disclaimer is enclosed to overcome the double patenting rejections at paragraphs 4 and 5 of the Office Action. Reconsideration and withdrawal of the remaining rejections are requested in view of the following remarks.

The claims describe improved cleaning methods and apparatus involving the use of a heated liquid layer on the surface of the workpiece through which large quantities of ozone diffuse. It is well known that adding heat will increase the reaction kinetics of an oxidizer, such

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March 21, 2003
Date of Deposit

Debbie Gilbert
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as ozone, thereby speeding up process times. However, it is also well known that the solubility of a gas such as ozone, in a liquid, such as water, decreases with increasing temperature. This characteristic inverse function of gas solubility versus liquid temperature suggests the use of liquid or water at room temperature or lower, in order to increase the level of dissolved ozone in the water. Indeed, various prior art techniques using chilled ozonated water have been proposed. While these techniques can achieve high levels of dissolved ozone, reaction times remain low due to the low temperatures. On the other hand, using water at high temperatures has not been effective, due to the decreasing concentration of ozone in the water as temperature increases.

The claimed methods and apparatus achieve the advantages of both high ozone concentration and high temperature, to provide fast reaction times, by using diffusion, rather than dissolution. While only a low amount of ozone can be dissolved within the heated liquid layer on the surface of the workpiece, large amounts of ozone can diffuse through the layer to react at the workpiece surface. Since none of the references suggests use of ozone at 90 gph, the combination of them necessarily also fails to suggest use of ozone at 90 gph.

All of the claims describe introducing ozone at a rate of at least 90 grams per hour (gph), or using an ozone supply system having a capacity of at least 90 gph. This claimed feature is not taught or suggested in any of the cited prior art. Indeed, the Office Action, at paragraph 2, states that "Li et al., Bergman and Matsuoka do not teach the ozone rate as claimed [90 gph]." Applicant submits that the cited references also do not suggest such a feature, or several of the other claimed features.

Li et al., the principle reference, describes a dry cleaning process, and specifically teaches away from employing a wet cleaning process (see cols. 1 and 2), as described in the claims. For example, Li et al. states that, "One of the drawbacks of wet cleaning is that surface tension can

prevent the liquid from penetrating into high aspect ratio features, leaving part of the surface uncleaned" (col. 1, lines 49-51). Accordingly, it is improper to combine Li et al. with references that teach wet cleaning processes, such as Bergman and Matsuoka (see MPEP § 2145(X)(D)(2), stating that, "it is improper to combine references where the references teach away from their combination").

Additionally, Li et al. discloses a surface diffusion layer (col. 4, lines 18-60), which is formed by depositing a vapor on the surface of a wafer (col. 4, line 42). Since Li et al. is a dry-cleaning process, the vapor layer is necessarily extremely thin, with no likelihood of the diffusion layer assisting in maintaining the workpiece at an elevated temperature, as claimed. Moreover, in Li et al., the purpose of the diffusion layer is to inhibit direct reaction of the gas phase with the wafer (col. 4, line 33), in order to eliminate surface roughness (col. 2, lines 38-46).

Thus, the intent of Li et al. runs opposite to the pending claims. The intent of Li et al. is to inhibit direct reaction of the gas phase with the wafer surface (col. 4, line 33), or, in other words, to decrease the mean free path and create a smooth silicon surface, with less pitting or scoring. Accordingly, Li et al. impliedly encourages using relatively low concentrations of ozone, so that ozone is less likely to directly react with the wafer surface. In contrast, the pending claims provide an increased amount of ozone to directly react at the workpiece surface, via diffusion of ozone through a heated liquid layer, which increases the reaction rate. Thus, Li et al. teaches away from using a high concentration of ozone, and clearly does not suggest providing ozone at the claimed rate of at least 90 gph.

Matsuoka discloses use of ozone and rotation of the workpieces, as noted by the Examiner at paragraph 2 of the Office Action. However, Matsuoka teaches away from using a heated liquid, as follows:

> "A problem with a dry treatment using ozone is that when resists implanted at high doses are treated at relatively high temperatures, pumping, etc., takes place through heat, making some resist residues likely to remain intact." Page 2, lines 56-58.
>
> "Heating the substrates does not permit wet ozone to have well-enough effects, because any thin water film cannot occur even when a wet ozone-containing gas is fed." Page 3, lines 34-35.

In example 1 in Matsuoka, the water is 25°C. In comparative example 1, the water is 20°C. Consequently, Matsuoka teaches away from heating, and it is improper to combine its teachings with a reference that teaches the use of a heated liquid to treat a workpiece (see MPEP § 2145(X)(D)(2)).

With respect to ozone consumption, Matsuoka suggests, in Example 1, an ozone rate of about 25 gph (based on the 6 lpm and 55,000 ppm parameters). There is no suggestion in Matsuoka to use a higher rate of ozone. The claims, conversely, recite that ozone is provided at a rate of at least 90 gph, i.e., at least a 350% increase over that which is taught in Matsuoka. It would not have been obvious for one skilled in the art to have increased the ozone rate by such a high percentage, since the claimed increase is so large.

Moreover, because Matsuoka teaches away from heating, the rate of reaction in Matsuoka is likely much lower than that of the recited claims, which all recite using a heated liquid. Thus, if ozone were introduced at the claimed rate in Matsuoka, much of the ozone would not be used to react with the wafer, and would therefore go to waste. Moreover, the excess ozone would have to be destroyed before release (due to the reactive/corrosive characteristics of ozone), which

can be costly and time-consuming. Accordingly, there is no suggestion in Matsuoka to introduce ozone at a high rate, such as the claimed rate of 90 gph.

Bergman teaches uniform etching of a wafer with HF and/or HCl, and makes no mention of using high capacity ozone. Thus, Bergman does not teach or suggest introducing ozone into a workpiece-containing environment at the claimed rate of at least 90 grams per hour.

Based on the foregoing, the combination of Li et al., Bergman, and Matsuoka does not render the claims obvious, because none of the references, alone or in combination, teach or suggest introducing ozone at the claimed rate of at least 90 gph. Accordingly, a *prima facie* case for obviousness has not been made (see MPEP §2143.03, stating that "to establish *prima facie* obviousness of a claimed invention, all the claim limitations must be taught or suggested by the prior art").

In view of the foregoing, it is submitted that the claims are in condition for allowance, and a Notice of Allowance is requested.

Respectfully submitted,

Perkins Coie LLP

Date: March 21, 2003

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Terminal Disclaimer

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Semitool, Inc., Assignee in the above-identified patent application by virtue of an Assignment recorded in the U.S. Patent and Trademark Office at Reel 012082, Frame 0012 on 08/13/01, hereby disclaims, except as provided below, the terminal part of the statutory term of any patent granted on the instant application which would extend beyond the expiration date of the full statutory term defined in 35 USC §154 to §156 and §173, as presently shortened by any terminal disclaimer, of

*U.S. Patent Application Nos. 09/929,437 and 09/925,884

The owner hereby agrees that any patent so granted on the instant application shall be enforceable only for and during such period that it and the above-listed patents and/or patent applications are commonly owned. This agreement runs with any patent granted on the instant application and is binding upon the grantee, its successors or assigns.

In making the above disclaimer, the owner does not disclaim the terminal part of any patent granted on the instant application that would extend to the expiration date of the full statutory term as defined in 35 USC §154 to §156 and §173 of the above-listed patents and/or applications, as presently shortened by any terminal disclaimer, in the event that said patent(s)/application(s) later: expires for failure to pay a maintenance fee, is held unenforceable, is found invalid by a court of competent jurisdiction, is statutorily disclaimed in whole or terminally disclaimed under 37 CFR §1.321, has all claims cancelled by a reexamination certificate, is reissued, or is in any manner terminated prior to the expiration of its full statutory term as presently shortened by any terminal disclaimer.

1. Certification under 37 CFR §3.73(b)

I, the undersigned, am empowered to act on behalf of the assignee. The evidentiary documents referred to above have been reviewed by the undersigned and it is certified that to the best of the Assignee's knowledge and belief, title is in the Assignee seeking to take action.

I declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further, that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

2. Fee Payment

The Commissioner is authorized to charge the $110.00 Terminal Disclaimer filing fee under 37 CFR 1.20 to Perkins Coie's Deposit Account No. **50-0665.** A duplicate copy of this sheet is enclosed.

Respectfully submitted,

Perkins Coie LLP

Date: March 21, 2003

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